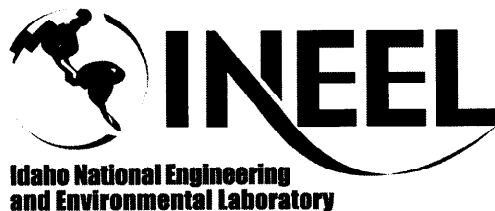


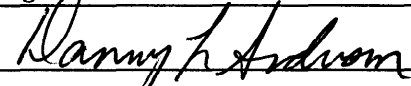
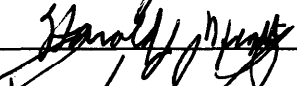
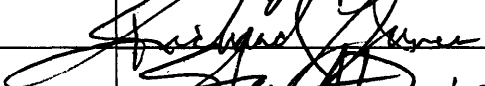

Engineering Design File

Operable Unit 7-13/14 Integrated Probing Project Vapor Port Instrumented Probe

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho



Form 412.14
07/24/2001
Rev. 03

1. Title: Operable Unit 7-13/14 Integrated Probing Project Vapor Port Instrumented Probe				
2. Project File No.: PF110.12				
3. Site Area and Building No.:			4. SSC Identification/Equipment Tag No.:	
5. Summary: The vapor port probes are Type B probes to be used in Phase II of the Operable Unit 7-13/14 integrated probing project. Vapor port probes collect soil gas samples from unsaturated soil for identification and characterization of volatile organic compounds, carbon-14, and tritium. A commercial, off-the-shelf instrument has been identified and selected. This Engineering Design File describes the vapor port probe.				
6. Review (R) and Approval (A) and Acceptance (Ac) Signatures: (See instructions for definitions of terms and significance of signatures.)				
	R/A	Typed Name/Organization	Signature	Date
Author	R	Danny L. Anderson		8/22/01
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7. Distribution: (Name and Mail Stop)		D. L. Anderson (5), A. R. Baumer, S. O. Magnuson, J. M. Hubbell, ER Document Control (3), G. A. Beitel, D. M. Everett, W. R. Horne, K. A. Wooley, R. L. Jones, T. E. Sluder, S. Sifuentes, S. J. Moody, M. A. Verdoorn, P. D. Ritter, S. A. Davies, R. D. Sayer		
8. Records Management Uniform File Code (UFC):			6400	
Disposition Authority: ENV1-k-2-b			Retention Period: Cutoff at project completion. Destroy 25 years after project completion.	
EDF pertains to NRC licensed facility or INEEL SNF program?: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
9. Registered Professional Engineer's Stamp (if required) N/A				

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ACRONYMS

ARA	Applied Research Associates
CPT	Cone Penetrometer Test
EDF	engineering design file
INEEL	Idaho National Engineering and Environmental Laboratory
OD	outside diameter
OU	operable unit
SDA	Subsurface Disposal Area
T&FR	technical and functional requirements
SST	stainless steel

Operable Unit 7-13/14 Integrated Probing Project Vapor Port Instrumented Probe

1. INTRODUCTION

This engineering design file (EDF) describes the design of the vapor port probes to be used in the Operable Unit (OU) 7-13/14 integrated probing project. This EDF is brief because the subject probe instrument is an existing, commercial, off-the-shelf product. Two needed components (probe casings and the cap) will require Idaho National Engineering and Environmental Laboratory (INEEL) design or fabrication, but they are described in other EDFs.

2. BACKGROUND

The OU 7-13/14 integrated probing project consists of two phases of probing to be performed in the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex to support the OU 7-13/14 comprehensive remedial investigation/feasibility study. The first phase of probing will use probes of the type successfully installed in Pit 9 for the OU 7-10 staged interim action. These Type A probes will be logged and used to site the instrumented (Type B) probes to be installed as the second phase of probing. The Type A probe is a capped pipe driven through the waste that allows nuclear logging instruments to be lowered into the waste for characterization. The Type B probes use a direct-push technology, with sonic assistance, as needed, to install tensiometers, suction lysimeters, soil moisture sensors, and vapor ports into and beneath the waste. This will allow long-term monitoring of the moisture within the pits and release of contaminants from the waste.

The vapor port probes described in this EDF are Type B probes that will be used to collect soil-gas samples to detect and characterize volatile organic compounds, carbon-14, and tritium.

3. REQUIREMENTS

Requirements for the vapor port probes are derived from *Technical and Functional Requirements for the Operable Unit 7-13/14 Integrated Probing Project Type B Probes* (T&FR) (INEEL 2001). Derived requirements are described below and are traced to the applicable requirements in the T&FR.

3.1 Soil Gas Collection

The vapor port probe will collect soil-gas samples at depths down to 25 ft (7.6 m).

Basis: T&FR Sections 3.1.2.1.1 and 3.1.2.3.2.

3.2 Material Chemical Compatibility

Probe casings, instruments, and sampling equipment will be fabricated using materials that are not chemically incompatible with the pit and soil vault row environments and moisture and gas sample chemical contents. The *OU 7-10 Materials Compatibility Study for Stage I and II Enclosures* EDF (O'Holleran 2000) will be used as a guide.

Basis: T&FR Section 3.3.2.1.

3.3 Design Life

The design life of the vapor port probe will be a minimum of 10 years; consumable, replaceable parts may have shorter design lives.

Basis: T&FR Sections 3.2.5.1 and 3.2.5.1.2.

Explanation: Even after the useful operating life has expired (see Paragraph 3.4), the instruments will have to maintain structural integrity, in conjunction with the probe casings and caps, to prevent releases of contaminated liquid or gas at the surface throughout a 10-year period from the date of installation.

3.4 Useful Life

The useful life of the vapor port probe will be at least 3 years, though not continuous or uninterrupted.

Basis: T&FR Section 3.2.5.2.

Explanation: The instrument must be capable of collecting samples throughout a 3-year period from the date of installation

3.5 Seals and Barriers

At least two seals, barriers, or valves will block all pathways within the probe strings that reach the surface, to minimize the likelihood of venting or spilling contaminant gases or liquids.

Basis: T&FR Section 3.1.2.1.2.

3.6 Physical Compatibility with Existing Drill Rig

The vapor port probe will be capable of being installed using the Modified Hawker Siddley Super Drill 150, Series 2, ResonantSonic Drill currently owned by Waste Area Group-7, in both direct-push and sonic-vibration modes.

Basis: T&FR Section 3.1.2.1.7.

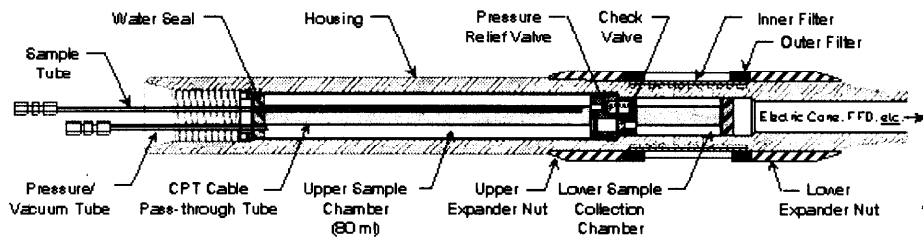


Figure 2. VERTEK ConeSipper schematic.

The body of the ConeSipper is made of 416 stainless steel. A series of O-rings and a compressible-gasket water seal, all made of Viton, provide at least two barriers to prevent gas or liquid from reaching the surface through any path other than the sample tubes. Internal gravity-operated valve seals at the start of the sample tube paths, also made of Viton, will provide the first barrier for this path. The second barrier will be provided by a valve at the other end of the tube, at the surface (see Section 4.2.3.1).

Two filters are incorporated to prevent larger particles from entering the probe sample chamber. The outer filter is a 254- μ -pass (0.01-in.) stainless steel, perforated cylinder. The inner filter is a 38- μ -pass stainless steel screen or mesh.

4.1.2 Sample Tubing

Two short, rigid, stainless steel tubes exit the ConeSipper. Flexible Teflon tubing is connected to each and is used to carry the samples to the surface. This tubing is 1/16-in. (1.6-mm) inner diameter by 1/8-in. (3.2-mm) outer diameter. The two Teflon tubes are joined to the stainless steel tubes using double male end, stainless steel, Swagelok unions. The two tubes will each be a different color so that the connections can be distinguished at the surface. One of the tubes will draw samples from the top of the 80-ml (2.7-oz) sample chamber and the other tube will draw samples from the bottom of the chamber. Gas samples should be drawn from the first tube, because the second tube is more likely to draw water if any is sitting in the bottom of the chamber. The length of the tubing will be 25 ft (7.6 m) to reach from the surface down to the maximum anticipated depth.

4.1.3 Probe Tip

The probe requires a tip to provide a durable bit for leading the probe downward as the probe is pushed into the ground. The VERTEK standard dummy tip will be used. It is a pointed cone with no teeth or auguring edge, as shown in Figure 3. The tip is made of 4340 carbon steel that has not been heat-treated. Initially, there was a recommendation to blunt the point of the standard tip to reduce heat generation. However, an analysis was performed and documented in *Operable Unit 7-13/14 Integrated Probing Project Thermal Analyses of Type B Probes Driven with the ResonantSonic Drill* (Beitel and McCreery 2000) that demonstrates that the standard tip is acceptable. The standard tip will be used as is.

4.2.2 Probe Casings

A segmented rigid pipe, referred to as the probe casing, will be used to drive the instrumented probe into the ground and to provide conduit for the flexible, internal tubing used to transfer soil-gas samples to the surface. These probe casings will be manufactured on-site by INEEL. The probe casings used for the vapor port probe are the same as those used for two other INEEL-fabricated Type B probes. They have a large, modified ACME-design box-thread joint, for quick assembly, and double O-rings at each joint. Details on these probe casings and joints, including drawings, can be found in *Operable Unit 7-13/14 Integrated Probing Project Type B Probe Casing Design* (Clark 2001). Figure 5 shows a cross-section of a probe casing and the thread joints at the each end.

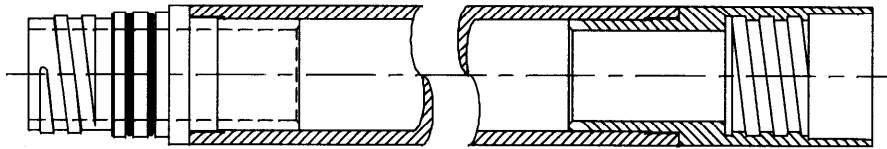


Figure 5. Probe casing segment.

A trade study was performed to determine whether the probe cases should be fabricated as one long segment, which would be crimped and cut if refusal was reached at a shallower depth than anticipated, or as multiple shorter segments that could be successively added until refusal was reached. The decision was made to use multiple shorter segments (Anderson 2000). However, the shorter the segments, the more segments will be required and the longer the drilling and driving process will take. The segments will be fabricated in varying lengths to allow the ability to customize the overall length of the probe string and the depth it can reach. The nominal length will be 5 ft (1.5 m) and they will not exceed 7 ft (2.1 m) in length.

Probe case segments will have an outer diameter of 2.5-in. (6.4 cm). This will provide the soil seal above the narrow waist of the ConeSipper, as mentioned earlier. It has been determined that this diameter is suitable for the planned lengths, to prevent buckling. Supporting analysis is included as Appendix C (Diameter Analysis).

4.2.3 Probe Casing Cap

A cap is required at the top of the probe casings to contain any gases that might leak through the barriers within the ConeSipper or in case the sample tubes fail over time. A cap has been designed for the lysimeter probe that is compatible with the vapor port, if one minor change is made. The needed change is the connector fittings in the interior (or the underside) of the cap. This design has been adapted accordingly and will be used. The vapor port probe casing cap is shown in Figure 6. Details can be found in Drawing 516595 in Appendix B. This cap has a male thread that fits into the top of the topmost probe casing. It includes a pair of independent shut-off valves, a weather enclosure box, and standardized connector fittings on the box exterior.

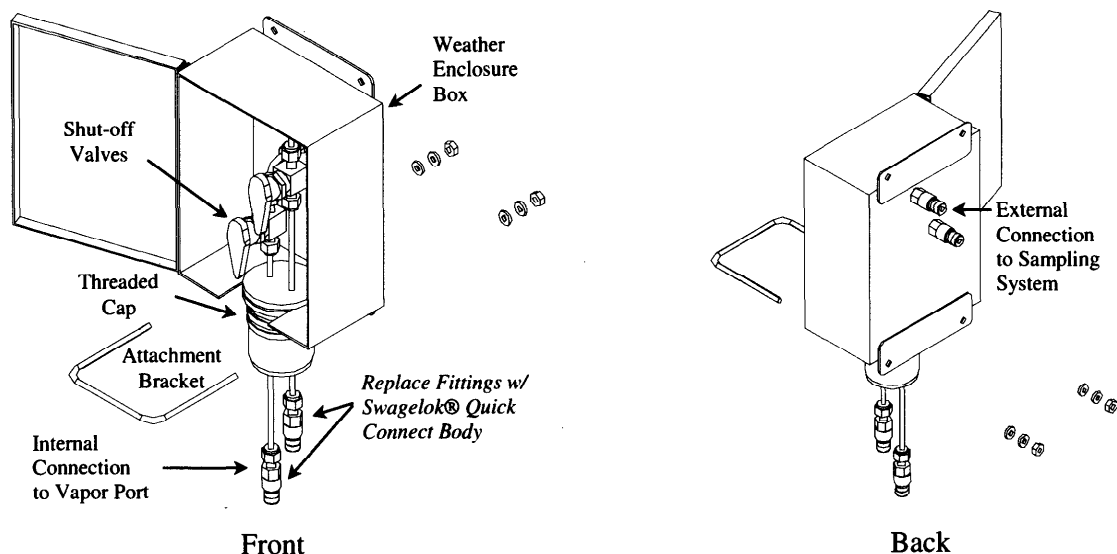


Figure 6. Vapor port probe casing cap.

4.2.3.1 Interface Between Vapor Port and Cap (Internal Sample Tube Connections).

The upper ends of the tubes will be sealed using Swagelok quick-connect stems with double-ended shut-off valves, part #SS-QC4-D-200, shown in Figure 7. The internal valve in these stems will provide the second barrier for the sample tube path. (The first barrier is the gravity valve at the start of the path, in the guts of the ConeSipper, as mentioned in Section 4.1.1.)

SS-QC4-D-200		Stem (male) Stainless steel with Viton seals Double-ended shut-off internal valve Fits 1/8-in. (3.2 mm) outside diameter (OD) tube
SS-QC4-B-400		Body (female) Stainless steel with Viton seals Internal body valve Fits 1/4" OD tube
SS-QC4-B1-400		Body (female) Bulkhead feed-thru Stainless steel with Viton seals Internal body valve Fits 1/4-in. (6.4 mm) OD tube.

Figure 7. Swagelok fittings for sample tubes.

In order to connect the sample tube fittings to the lysimeter cap, the fittings on the cap will have to be changed. The needed fitting on the interior (underside) of the cap is a Swagelok quick-connect body, part #SS-QC4-B-400, shown in Figure 7.

If the tubing is longer than needed, the excess will be stuffed down into the probe casing. If it will not fit, the tubing will be cut and the fittings reattached. Any cutting and reattachment of fittings will have

to be done within a sealed bag. The bag is a precaution to prevent the possibility of a contamination release if the lower valve has failed and the tube has filled with contaminated gas or water.

4.2.3.2 Interface Between Cap and Sampling Systems (Exterior Connections). The sample tubes within the probe casings will be connected to the interior of the cap. One of three gas sampling systems, which are separate systems used to collect the gas samples from the vapor port probes, will connect to the exterior of the cap. The following are the gas-sampling systems:

1. The primary soil-gas sampling system for use in the pits (Sifuentes 2001)
2. The carbon-14 soil-gas sampling system for the soil vault rows
3. Tritiated soil-gas sampling system for the soil vault rows (Anderson 2001).

These systems will provide the connectors, tubing or hoses, vacuums, and containers necessary to attach to the probe casing cap and draw the samples up from the vapor port sample chamber. The connector fitting on the exterior of the cap weather-enclosure box is a Swagelok quick-connect body, part #SS-QC4-B1-400 (bulkhead), shown in Figure 7. The sampling systems will require a compatible stem fitting.

4.3 Chemical Compatibility

The materials that will come in contact with liquid and gas samples are stainless steel, Viton, and Teflon. All of the products are declared acceptable in *OU 7-10 Materials Compatibility Study for Stage I and II Enclosures* (O'Holleran 2000).

4.4 Assembled Probe String and Installation

Figure 8 shows a representation of the major components involved in the vapor port probe string. Appendix D (Parts List) provides a parts list. The vapor port probe will be capable of being installed using the Modified Hawker Siddley Super Drill 150, Series 2, ResonantSonic Drill, currently owned by Waste Area Group-7, in both direct-push and sonic-vibration modes. The drill rig will perform direct push only, for as long as possible. When direct pushing ceases to advance the probe string, if the desired depth has not been reached and it is felt that refusal has not been reached, then sonic vibration mode will be engaged to drive the probe further, if possible. The probe string should not be rotated during insertion. The ARA has warned that rotation can clog the filter cylinder, making it difficult to collect samples. If the filter becomes clogged, back-flushing the system is possible, but there are project safety constraints that place limits on the amount of water that can be placed in the soil and waste.

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